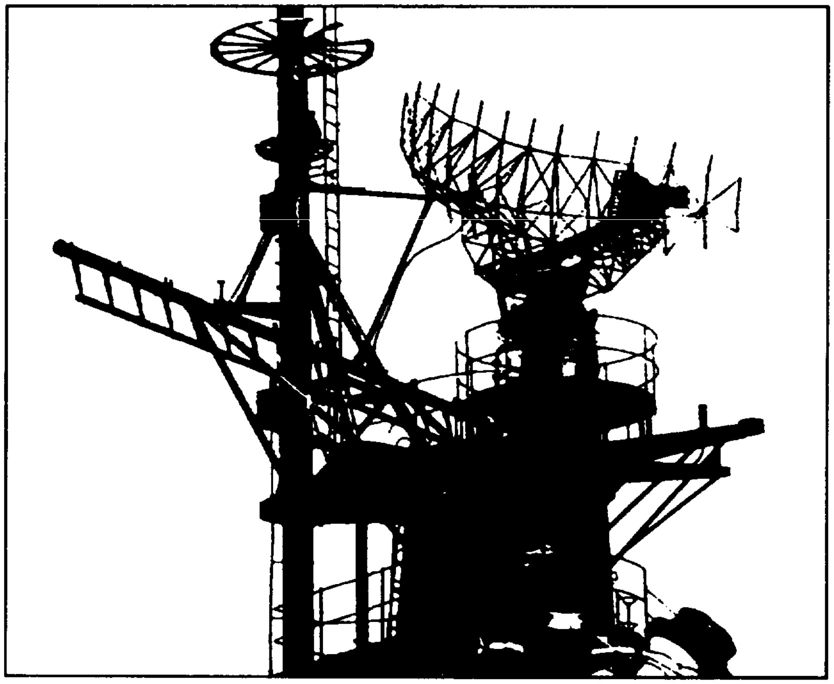
CHAPTER 2

RADAR SYSTEMS EQUIPMENT CONFIGURATIONS



In chapter 1, we discussed the configuration of a basic pulse radar system and the three basic types of radar sets. We cannot cover in one chapter every radar used by the Navy or every application of radars at the various units. Therefore, this chapter will present only a general overview of commonly used radars. We will not teach you specific equipment, but *will* help you identify and understand the operation of surface search/navigation radars, air search radars, 3D radars, CCA/GCA radars, and various repeaters used in the Navy today. For each type of radar, we will provide a basic system description, followed by its "theory of operation" and a brief explanation of the maintenance concept.

Most of the radar equipment discussed in this chapter has specific maintenance training available. However, except for certain crypto equipment, you do not need *specific* training to work on the gear. By combining the information in the appropriate technical manual with your extensive basic electronics background from "A" school and the general knowledge you get through training manuals and on-the-job training, you can become an expert maintainer of ANY electronic equipment.

You'll be surprised at how much you can figure out on your own. And if you ever get stumped, there are ways to get help. You may request maintenance assistance from tenders, repair ships, Mobile Technical Units (MOTUs), or NAVSEA field activities. In addition, Direct Fleet Support (DFS) will resolve maintenance repair problems beyond the capability of ship's force, Ship Repair Facilities (SRFs), Intermediate Maintenance Activities (IMAs), and MOTU personnel. If you need DFS assistance, submit a request to the applicable NAVSEACEN via your type commander, as prescribed in NAVSEAINST 4350.6.

The first radars we'll talk about are the surface search and navigation radars.

SURFACE SEARCH AND NAVIGATION RADARS

Recall from chapter 1 that the two main functions of surface search and navigation radars are to (1) detect surface targets and low-flying aircraft and (2) determine their range and bearing. Some of the more commonly used surface search and navigation radars in the Navy are the AN/SPS-10, AN/SPS-67(V), AN/SPS-64(V)9, and AN/SPS-55. Since the AN/SPS-10 will soon be replaced by the similar AN/SPS-67(V), we will not discuss the AN/SPS-10 in this chapter.

AN/SPS-67

The AN/SPS-67(V) radar is a two-dimensional (azimuth and range) pulsed radar set primarily designed for surface operations. It can also detect antiship-missiles (ASM) and low-flying aircraft. The AN/SPS-67(V)1 is the primary surface search and navigation radar, with limited air search capability, for the following types of ships:

AO	CG	DDG	LHD
AOE	CGN	FF	LPH
AOR	CV	LCC	LSD
BB	CVN	LHA	TAH

On DDG51 class ships, the AN/SPS-67(V)3 radar performs navigation, station keeping and general surface search duties. Additionally, the AN/SPS-67(V)3 supports the combat systems as shown below:

- Primary combat mission (ASUW)—provides a quick reaction, automated target detection and track capability
- Secondary combat mission (AAW)—detects low elevation (conventional) threats.

General Theory of Operation

The AN/SPS-67(V) radar set operates in the 5450- to 5825-MHz frequency range, using a coaxial magnetron as the transmitter output tube. To enhance radar performance for specific operational or tactical situations, the receiver-transmitter can operate in a long (1.0 %sec), medium (0.25 %sec), or short (0.10 %sec) pulse mode. The corresponding pulse repetition frequencies (prf) are 750, 1200, and 2400.

The AN/SPS-67(V)3 version has a new, high data rate, nuclear survivable, low-profile antenna and pedestal assembly that replaces the AN/SPS-10 antenna and pedestal assembly. In addition, the synchro signal amplifier function is integrated into the radar.

Some special operating features included in the AN/SPS-67(V) radars areas follows:

- Automatic Frequency Control (AFC)
- Automatic tuning
- Fast Time Constant (FTC)
- Interference Suppression (IS)
- Anti-log circuit (Target Enhance)
- Sensitivity Time Control (STC)
- Video Clutter Suppression (VCS)
- Built-In-Test (BIT) Equipment
- Sector Radiate (SR)
- Ships Heading Marker (SHM)
- Jitter mode
- Stagger mode

The following additional special operating functions are included in the AN/SPS-67(V)3 model:

- Synthesized Channel Frequency Selection
- RF Sensitivity Time Control (RFSTC)
- Antenna bearing squint correction
- Digital relative to true bearing conversion
- Full-time relative and true bearing synchro output at the ante ma controller
- Relative or true bearing synchro output selectable at the Radar Set Control (RSC) for the video processor unit
- Digital Moving Target Indicator (DMTI)
- Selectable environmental sector
- Constant False Alarm Rate (CFAR) threshold gating by external control
- Centroid function
- Track function
- Coherent EMI suppression in the DMTI channel
- Jam strobe detection
- Wraparound test by external control
- Target selectable threshold gating by external or internal control

Configuration

The major units of the AN/SPS-67(V)1 and (V)3 radar sets are shown in figure 2-1 and figure 2-2 respectively. As you can see, there is only a slight difference between the AN/SPS-67(V)1 and the AWSPS-67(V)3 versions. Think back to the basic block diagram of a pulse radar in chapter 1 (fig. 1-4). Relate the function blocks in figure 1-4 to the basic units shown in figure 2-1. If you understand the basics, you'll find that no matter how many special operating functions a radar has, the basic system is still the same.

The receiver-transmitter and video processor components of the AWSPS-67(V) bolt to the same bulkhead foundations used for the AN/SPS-10 series components. The remaining components mount in the same area of the units they replace, although they may or may not have the same shape as the AN/SPS-10 components. The dummy load mounts on the output of the receiver-transmitter unit.

SIGNIFICANT INTERFACES.— Although radar systems provide valuable information by themselves, the interface of that information with other warfare systems is critical.

The AN/SPS-67(V)1 meets interface requirements of the following equipment:

- Electronic Synchronizer, AN/SPA-42 or AN/SPG-55B
- Blanker-Video Mixer Group, AN/SLA-10( )
- IFF Equipment
- Indicator Group, AN/SPA-25( ) or equivalent
- Synchro Signal Amplifier, Mk 31 Mod 8A or equivalent

The AN/SPS-67(V)3 meets interface requirements for the following additional equipment:

- Shipboard Emission Monitor-Control Set, AN/SSQ-82(V) (MUTE)
- Data Multiplex System, AN/USQ-82(V)
- Signal Processor Converter Group, OL-191(V)5/UYQ-21(V)
- Command and Decision System, Mk-2
- Gyro Digital Converter, P/O Mk-38/39 and ACTS Mk-29
- Surveillance and Control System, AN/SPY-1

FOR THE MAINTAINER.— The AF/SPS-67(V) is a solid-state replacement for the AN/SPS-10 radar system. Miniature and micro-miniature technologies are used throughout the radar set. It is more reliable and has better logistical support, with 92 percent of its construction being Standard Electronic Modules (SEM).

The Built-in-Test (BIT) microprocessor sub-assembly uses on-line performance sensors to decrease the chance of operating the radar with an undetected fault. Using BIT circuitry during normal operation will not degrade system performance, nor will faulty BIT circuitry affect system performance. When system failures *do* occur, you can use BIT to isolate 95 percent of the possible faults to a maximum of four modules within the receiver-transmitter or video processor.

BIT circuitry uses light-emitting diodes (index indicators) at certain test points to indicate the locations of faults. The condition of the system at each test point is displayed on readout indicators as GO, MARGINAL, or NO-GO. In addition, the BIT subsystem provides an interactive test mode that permits you to monitor certain test points while making level or timing event adjustments. Power and voltage standing wave ratio (vswr) are monitored on an on-line basis. The BIT subsystem also automatically tests itself periodically by going into a self-check mode.

Maintenance

The AN/SPS-67(V) radar set operates continuously during the ship's deployment. The responsibility for the organizational level maintenance falls on the ship's Electronics Technicians, (NEC ET-1507.)

Organizational level maintenance consists of preventive maintenance (PM) and corrective maintenance (CM). PM is performed according to maintenance requirement cards (MRCs) developed for the AN/SPS-67(V) system. PM at this level includes checks of operational status and filter/equipment cleaning. CM is performed according to the AN/SPS-67(V) technical manual procedures, and includes removing and replacing chassis-mounted piece parts, modules, assemblies, and sub-assemblies.

Repairable modules, assemblies, and sub-assemblies are returned to the depot according to Navy supply procedures.

AN/SPS-64(V)9

The AN/SPS-64(V)9 radar is a two-dimensional (2D) navigation/surface search radar used as a primary radar on small combatants and various non-combatant

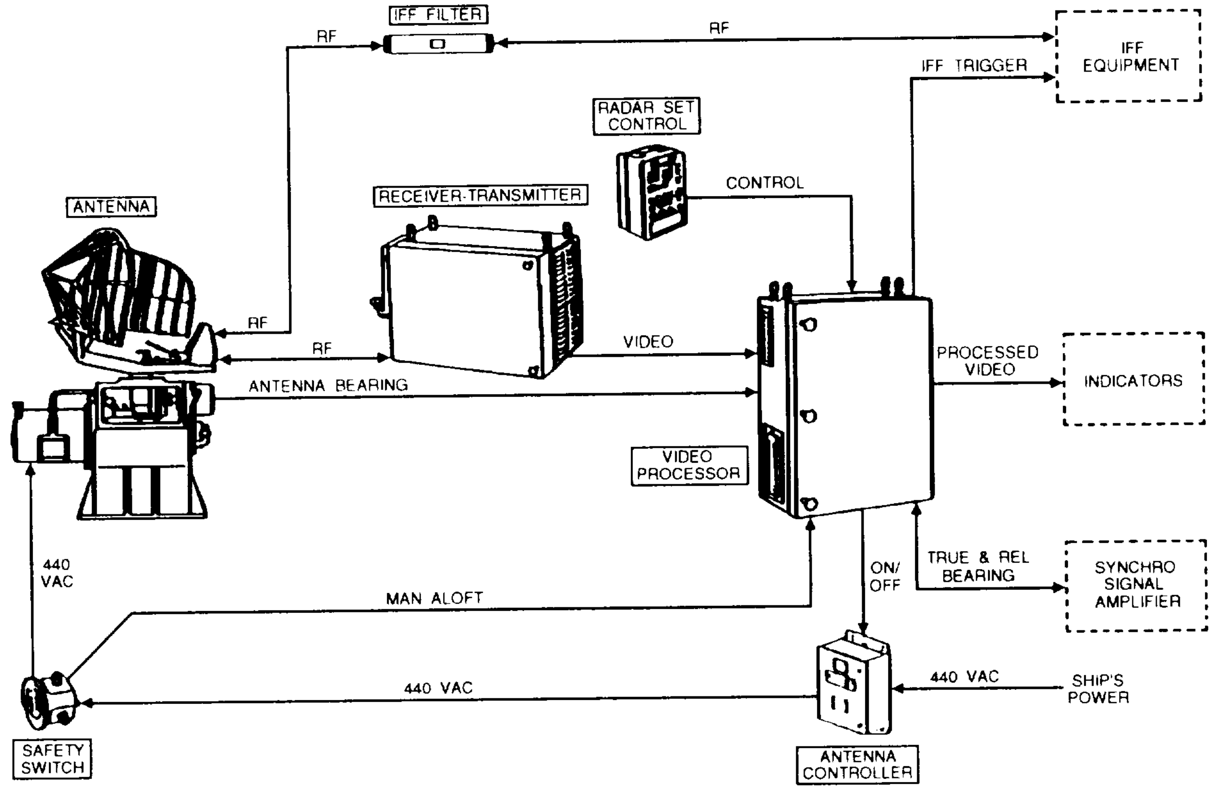


Figure 2-1.—AN/SPS-67(V)1 radar.

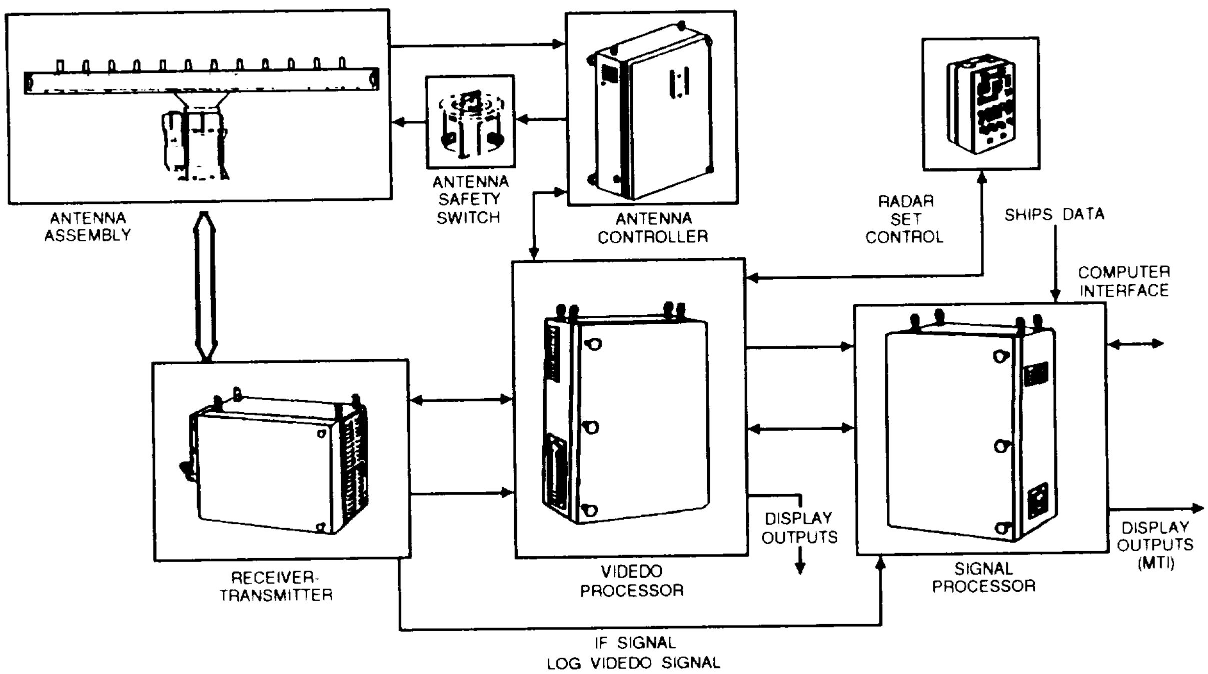


Figure 2-2.—AN/SPS-67(V)3 radar.

ships. It is also used as a back-up radar on large combatants. It provides a true bearing display for coastal piloting and a capability for radar navigation and station keeping.

The AN/SPS replaces a variety of small commercial radars on the following types of ships:

AE	ASR	CGN	FFG	LPH
AGDS	ATS	CV	LCC	LST
AOE	AVT	CVN	LHA	MHC
ARL	BB	DDG	LHD	MSO
ARS	CG	FF	LPD	PHM

General Theory of Operation

The AN/SPS-64(V)9 has a minimum detection range of 20 yards on a radar cross-sectional target of 10 square meters, 3 feet above the surface of the water. It can operate in either true or relative bearing when used with Navy gyrocompasses.

Some special operating features of the radar include:

- Ship line voltage protection
- Ship Heading Marker (SHM)
- Variable range marker

Configuration

Figure 2-3 provides a general overview of how this radar operates. Unlike the AN/SPS-67 radars, this off-the-shelf radar system was not designed to use existing antennas and indicators. All the components, including the indicator and the antenna system, are unique to the AN/SPS-64(V)9.

SIGNIFICANT INTERFACES.— Information from the AN/SPS-64(V)9 interfaces with the following Navy equipment:

- Blanker/Video Mixer Group, AN/SLA-10
- Indicator Group, AN/SPA-25( ) or equivalent
- Synchro Signal Amplifier, Mk 27 or equivalent
- Mk 19 gyrocompass or equivalent

FOR THE MAINTAINER.— The AN/SPS-64(V)9 is designed and constructed according to the best

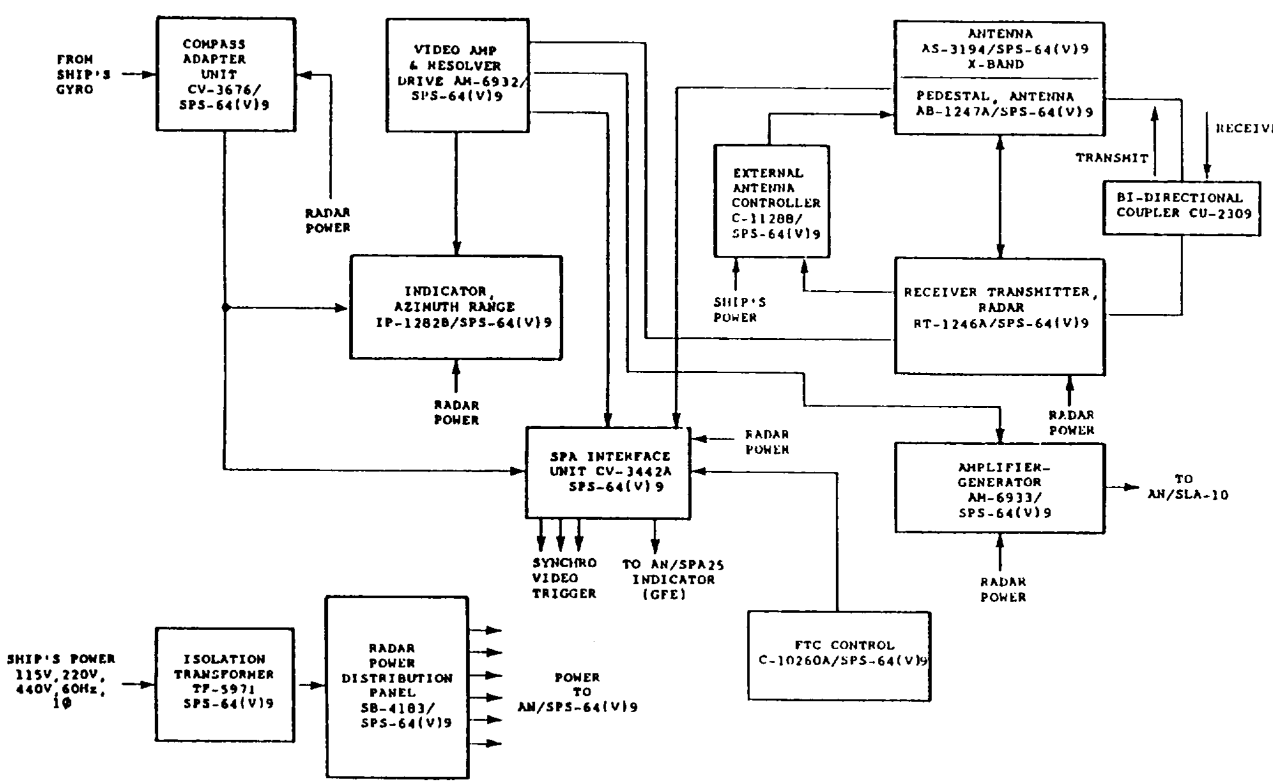


Figure 2-3.—AN/SPS-64(V)9 radar block diagram.

commercial practices. For example, there are safety interlocks on the antenna pedestal, the receiver/transmitter (R/T) unit, and the azimuth range indicator. All the other units include ON/OFF switches and indicator lights.

Maintenance

The AN/SPS-64(V)9 was purchased as the single, commercially available, off-the-shelf radar for the Navy's Class B1 radar program. Maintenance support, including documentation, spares, and levels of maintenance is also an off-the-shelf concept.

Maintenance responsibilities are assigned to an existing billet and performed by an Electronics Technician (no specific NEC assigned). Organizational level maintenance consists of preventive maintenance (PM) and corrective maintenance (CM). PM is done according to the maintenance requirement cards (MRCs). CM consists of (1) adjustments, alignments, and tests, as described in the technical manual and (2) replacement of the lowest replaceable unit (LRU) required to correct radar discrepancies.

The Miniature/Microminiature (2-M) Electronic Repair Program and the Support and Test Equipment Engineering Program (STEEP) are not used for the AN/SPS-64(V)9 radar, since the Navy has no data rights for the equipment.

Major overhaul and restoration of the AN/SPS-64(V)9 radar and LRU repair are performed at the depot level, in the prime contractor's facility. Technical Repair Standards (TRSs) are not available since the Navy does not make depot-level repairs.

AN/SPS-55

The AN/SPS-55 is a solid-state, Class A surface search and navigation radar. It is used to detect small surface targets and for navigation and pilotage. The AN/SPS-55 radar detects targets from as close as 50 yards to as far as 50 nautical miles. It was specifically designed for installation in the following new-construction ship classes:

AO-177	CGN-38	DDG-993	MCM-1
CG-47	DD-963	FFG-7	PBC-1

A radar video converter (RVC) modification was developed for AN/SPS-55s used on the FFG-61 class.

The AN/SPS-55 radar supports several mission areas including Antisurface Warfare (ASUW), Antisubmarine Warfare (ASW), Amphibious Warfare (AMW), Special Warfare (SPW), Mobility (MOB), and Command and Control (CAC).

General Theory of Operation

The radar set operates from 9.05 GHz to 10 GHz, and can tune over the entire bandwidth within 60 seconds. Tuning can be controlled from either the remote radar set control (RSC) or the receiver-transmitter (R/T) unit. The transmitter uses a magnetron with a minimum peak power of 130 KW. The receiver can operate in a long-pulse mode (1.0 %sec) or short-pulse mode (.12 %sec) with minimum ranges of 200 yards and 50 yards respectively. The antenna consists of two back-to-back end-fed, slotted waveguide arrays with a scan rate of 16 rotations per minute (rpm).

Some special operating features of the AN/SPS-55 radar set include:

- Squint compensation
- Variable sensitivity time control
- Fast time constant (FTC)
- Log/linear-log intermediate frequency (IF) amplifier
- Video blanking circuit
- Sector radiate capability
- Automatic and manual frequency control (AFC/MFC)

The RVC modification provides these additional features:

- Analog/digital (A/D) conversion
- Digital integration with beam time interval
- Noncoherent DMTI
- Moving window constant false alarm rate (CFAR) thresholding
- Segmented CFAR

Configuration

As shown in figure 2-4, the major components of the AN/SPS-55 radar include the antenna, the

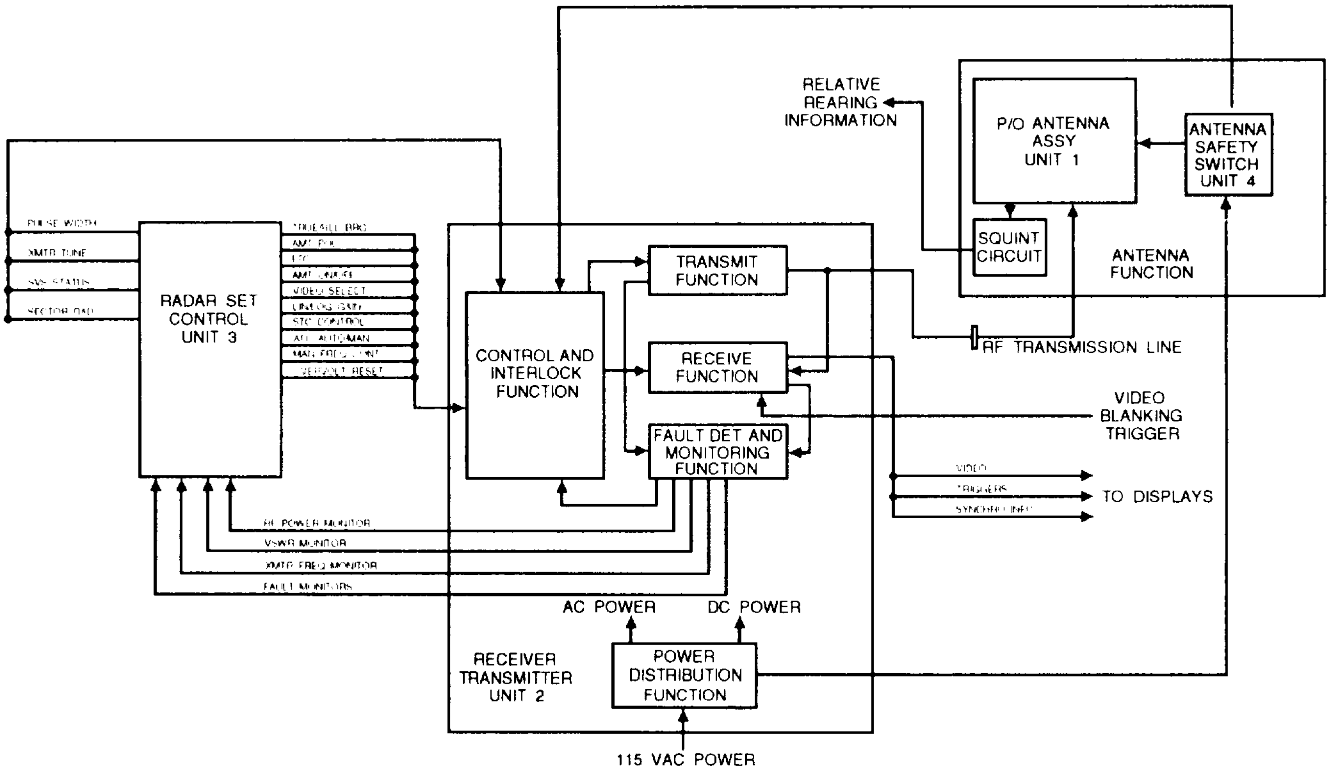


Figure 2-4.—AN/SPS-55 block diagram.

receiver-transmitter (R/T), the radar set control (RSC), and the antenna safety switch.

Although the AN/SPS-55 radar is electronically reliable, the antenna pedestal has been a source of mechanical maintenance problems. A field change kit, developed in FY89, provided an improved antenna pedestal. Delivery and installation of the pedestal modification are coordinated by the Restoration Program Manager.

SIGNIFICANT INTERFACES.— The AN/SPS-55, like all radars, has an impact on other systems, subsystems, and equipment. The RVC modification developed for the FFG-61 and the antenna pedestal modification not only improved the radar set, but improved the interface capabilities. The RVC enables the FFG-61 Integrated Automatic Detection and Tracking System (IADT) to use the AN/SPS-55 data. The pedestal modification allows interface with IFF.

The AN/SPS-55 interfaces with the following equipment:

- Blanker/Video Mixer Group, AN/SLA-10
- Indicator Group, AN/SPA-25( ) or equivalent
- Mk 27 synchro signal amplifier or equivalent
- Mk XII IFF (pedestal mod only)
- AN/SYS-2(V)2 IADT (FFG-61 RVC mod only)

FOR THE MAINTAINER.— The AN/SPS-55 radar has various built-in features to protect the maintainer and the equipment. The transmitter has a voltage standing wave ratio (vswr) alarm. Fault detection indicators, located on both the transmitter and the RSC unit, show when the high-voltage power supply, modulator, or magnetron exceeds predetermined safe limits. A low-power condition in the radar automatically places the radar in the standby mode and activates an indicator at the RSC when low power exists.

The antenna safety switch, when activated, opens the radiate interlock, removing power from the drive motor. It also activates a “Man Aloft” indicator on both the R/T and the RSC unit to ensure that no one tries to operate the radar during maintenance.

Maintenance

Maintenance of the AN/SPS-55 consists primarily of module replacement, with limited repair or replacement of certain individual components. The equipment is designed for rapid fault isolation to the lowest replaceable unit (LRU). The technical manual lists the assemblies and components that can be replaced during organizational level maintenance.

Electronics Technicians (NEC ET-1491 for FFG-7 Class ships or ET-1504 for all other ships) are responsible for organizational level maintenance of the AN/SPS-55. Preventive maintenance (PM) and corrective maintenance (CM) include:

- electrical and mechanical alignments;
- adjustments, and calibration;
- fault detection, isolation, and module or major part repair/replacement; and
- all correction and verification necessary to restore the radar set to an operating condition.

Disposition and repair of failed components is specified by the Source, Maintenance, and Recoverability (SM&R) codes in the applicable Allowance Parts List (APL). Send your repairable modules to the Designated Overhaul Point (DOP) for repair or condemnation.

AIR SEARCH (2D) RADARS

The two primary functions of air search radar are to (1) detect aircraft targets at long ranges and (2) determine their range and bearing. Some of the most widely used two-dimensional (2D) air search radars in the Navy are the AN/SPS-37A, AN/SPS-43, AN/SPS-43A, AN/SPS-49(V), AN/SPS-40B/C/D/E, and AN/SPS-65(V) aboard ships and the AN/GPN-27 (ASR) at shore installations.

We will not discuss the AN/SPS-29, AN/SPS-37, and AN/SPS-43 radars, since the AN/SPS-49(V) radar replaces them.

AN/SPS-49(V)

The AN/SPS-49(V) radar is the primary U.S. Navy early warning air search 2D radar. It is a very-long-range radar, and provides long-range air surveillance in severe clutter and jamming environments. It primarily supports the anti air warfare (AAW) mission on surface ships, but also provides backup to the 3D weapon system radar. The AN/SPS-49(V) radar is also used for air traffic control (ATC), air intercept control (AIC), and antisubmarine aircraft control (ASAC).

The AN/SPS-49(V) radar replaces the AN/SPS-29, AN/SPS-37, AN/SPS-40, and AN/SPS-43 radars in some ships, including the following ship types:

CG	CV	DDG	LHD
CGN	CVN	FFG	LSD

Current planning calls for installation of the AN/SPS-49(V) radar in 160 U.S. Navy ships, plus various shore installations.

General Theory of Operation

The AN/SPS-49(V) is a narrow-fan beam radar developed from a Specific Operational Requirement. It provides the capability to conduct air search operations on a previously unused radar frequency. This minimizes electronic interference between ships and increases the difficulty for hostile electronic countermeasures (ECM). The AN/SPS-49(V) provides good bearing measurements to backup the 3D radar weapons system. Its narrow beamwidth substantially improves resistance to jamming.

The coherent side lobe canceler (CSLC) cancels jamming and interference signals, providing the AN/SPS-49(V) radar further resistance to jamming and interference. The DMTI capability enhances detection of low-flying, high-speed targets.

The AN/SPS-49(V)5 version, which has automatic target detection (ATD) capability, has even more sophisticated antijamming features. This version offers improved clutter suppression and a digital interface to the AN/SYS-2(V) IADT system. The AN/SPS-49(V)5, does not cancel non-moving targets as with MTI, instead it uses the newest development in doppler processing, Finite Impulse Response (FIR) fibers. These filters separate radar echo returns into fixed and moving channels according to their doppler characteristics. The moving channels contain moving targets only. The fixed channels contain fixed clutter and blind speed targets. Rejection of non-moving targets recurs at a later point in time in the clutter maps.

The “AEGIS Tracker” modification consists of a PCB card set integrated into the signal data processor. It adds an embedded tracker, with direct digital interface with the AEGIS combat system, to the AN/SPS-49(V)7 radar (installed on AEGIS cruisers). With this modification incorporated, the AN/SPS-49(V)7 nomenclature changes to AN/SPS-49(V)8.

The digital coherent side lobe canceler (DCSC) is part of the Medium PRF Upgrade (MPU) modification.

It improves performance against small targets when subjected to stand-off jamming. The modification primarily replaces the receiver's *sensitivity time control* (STC) with a *sensitivity velocity control* (SVC). SVC uses radial velocity and target size information to "filter" out birds and near-in clutter. It suppresses these unwanted targets while retaining detection performance throughout the volume of coverage. The MPU also aids in reducing reaction time to only two scans by providing very high-quality velocity estimates for radar targets.

Configuration

The AN/SPS49(V) radar set contains 47 major units in nine variant configurations, (V)1 through (V)9. Figure 2-5 shows the physical configuration of the AN/SPS-49(V) radar system.

The nine variant configurations are:

- (V)1 Baseline radar
- (V)2 AN/SPS49(V)1 radar without the coherent side lobe cancellation feature
- (V)3 AN/SPS-49(V)1 radar with the radar video processor (RVP) interface (FC-1)
- (V)4 AN/SPS49(V)2 with the RVP interface
- (V)5 AN/SPS-49(V)1 with automatic target detection (ATD)
- (V)6 AN/SPS-49(V)3 without the cooling system
- (V)7 AN/SPS-49(V)5 without the cooling system
- (V)8 AN/SPS-49(V)7 with automatic detection and tracking (ADT)
- (V)9 AN/SPS-49(V)5 with medium PRF upgrade (MPU)

SIGNIFICANT INTERFACES.— The AN/SPS-49(V) radar interfaces with shipboard display systems via conventional radar switchboards and NTDS switchboards. Field Change 1 provides an optional interface through the Dual Channel RVP and associated equipment. In addition, the AN/SPS-49(V)5 version interfaces with the AN/SYS-2(V) MDT system.

FOR THE MAINTAINER.— Solid-state technology with modular construction is used throughout the radar, except for the klystron power amplifier and high-power modulator tubes. Digital processing techniques are used extensively in the AN/SPS-49(V)5, 7 and 8.

The radar has comprehensive BIT features, such as performance monitors, automatic fault detectors, and built-in-test equipment (BITE). The AN/SPS-49(V)5, 7, and 8 include automatic, on-line, self-test features. Each major unit has test panels with fault indicators and test points. There is also a test meter to monitor system power supply voltage.

Maintenance

The AN/SPS-49(V) radar operates continuously during deployment. Radar maintenance is a responsibility of the ET rating (NEC ET-1503 for (V)1, 2, 3, 4, and 6 or ET-1510 for (V)5, 7, 8 and 9). Basic maintenance involves module replacement and planned maintenance (PM) and follows the policies set forth in NAVSEAINST 4700,1 and NAVMATINST 4700.4B.

Organizational maintenance consists of PM and CM, performed on the radar in place, while the ship is underway. CM is limited to (1) fault isolation, (2) removal and replacement of modules or cabinet-mounted piece parts, and (3) the adjustment, alignment, and testing required to correct the radar degradations. All repairable modules are shipped to DOP for repair as directed by SPCC Mechanicsburg.

Removing and replacing the radar antenna and various major antenna subassemblies require intermediate-level maintenance. These tasks are conducted as directed by the NAVSEASYSCOM Restoration Program.

AN/SPS-40B/C/D/E

The AN/SPS-40B/C/D/E is the primary shipboard long-range, high-powered, two-dimensional (2D), air search radar. It provides 10-channel operation, moving target indicator (mti), pulse compression, and high data short range mode (SRM) for detecting small, low-altitude, close-in targets. Designed for use aboard frigate-size or larger ships, the AN/SPS-40B/C/D radar is used on the following types of ships:

AVT	FF	CC	CGN	DDG

Field Change 11, which changes the nomenclature to AN/SPS-40E, replaces the tube-type power amplifier with a solid-state transmitter (SSTX) and provides a substantial improvement in operational availability. The AN/SPS-40E radar is used on the following types of ships:

AGF	DD	LHA	LPH
AOE	LCC	LPD	LSD

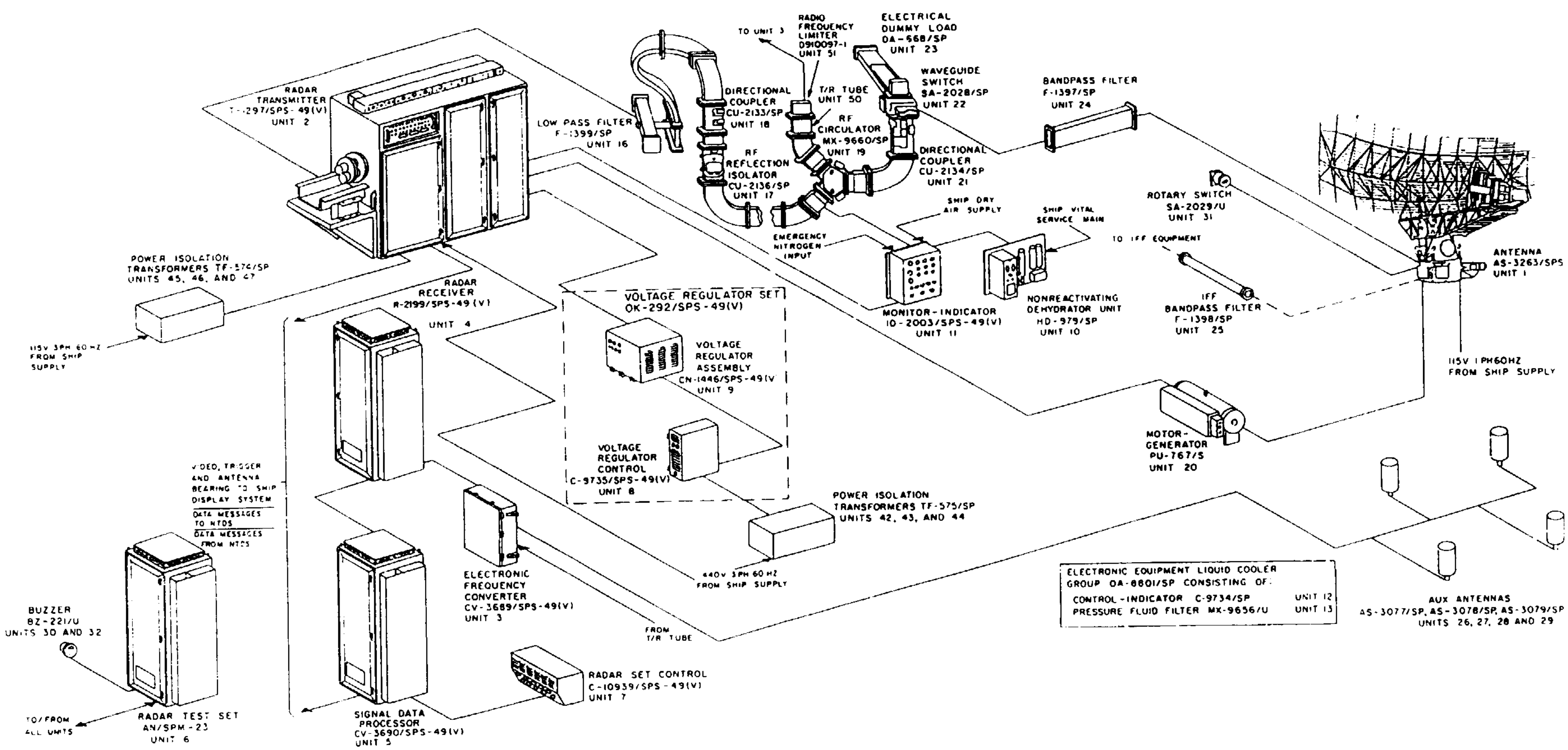


Figure 2-5.—AN/SPS-49(V) radar system.

The many changes to this radar set have improved its minimum range capability, as well as made it more reliable and easier to maintain.

General Theory of Operation

The AN/SPS-40 radar set, with the automation module, is better able to detect targets over land and water and to generate clutter-free target data. It has a two-speed drive motor, which increases the antenna rate to 15 rpm for high-data rate capabilities and operates at a normal 7.5 rpm speed in the long-range mode (LRM).

Some special operating features of the AN/SPS-40B/C/D/E include the following:

- DMTI
- Long-range, long-range/chaff, and short-range modes
- Automatic target detection (ATD)
- Built-in-test (BIT) equipment
- Analog/digital conversion
- Four-pulse staggered pulse repetition frequency (prf)
- Operator selectable antenna scan rate
- Sensitivity time control (STC)

Configuration

Figure 2-6 illustrates the AN/SPS-40B/C/D DMTI/RVC radar system. The DMTI field change replaces the analog moving target indicator with more reliable and more easily maintained digital circuitry. It also provides a new radar set control (RSC) and replaces the duplexer with a solid-state unit. The RVC field change allows the radar to interface with the AN/SYS-1 IADT system.

Installation of the solid-state transmitter, field change (FC-11), replaces 11 shipboard units (units 2, 3, 4, 6, 16, 17, 18, 19, 21, 23, and 25) with five units (units 28 through 32) as shown in figure 2-7.

SIGNIFICANT FIELD CHANGES.— As we mentioned before, this radar set has had many changes. Some of the more significant field changes are:

- Digital moving target indicator (DMTI)—solid-state upgrade
- Radar video converter (RVC)—interface with AN/SYS-1
- Solid-state transmitter (SSTX)—changes the number of units in the configuration and the nomenclature of the system
- AN/SPS-40E Field Change 2—changes the two-cabinet PA configuration to a single cabinet PA
- AN/SPS-40E Field Change 3—replaces the DMTI with a new coherent receiver processor

SIGNIFICANT INTERFACES.— The An/SPS-40B/C/D/E interfaces with shipboard display systems via conventional radar switchboards and NTDS switchboards. The AN/SPS-40B/C/D/E radar with DMTI/RVC interfaces with the AN/SYS-1 Integrated Automatic Detection and Tracking System (IADT).

FOR THE MAINTAINER.— The increased use of solid-state design and modular construction in the AN/SPS-40 radar results in a longer mean time between failures (MTBF) and a shorter mean time to repair (MTTR). The new receiver and mti both use built-in-test equipment to help in alignment and troubleshooting.

Maintenance

The AN/SPS-40B/C/D/E radar is designed for continuous operation during deployment. The maintenance responsibilities are assigned to the ET rating (NEC ET-1516, ET-1508 (with DMTI), and ET-1511 (with FC-11)). The SPS-40's modular design minimizes maintenance actions at the organizational level.

Organizational maintenance includes preventive and corrective maintenance. PM is performed according to technical manuals and maintenance requirement cards (MRCs).

CM is performed according to the corrective maintenance section of the technical manuals and by the Source Maintainability and Recovery (SM&R) code assigned in the APL. You may be required to perform any of the following actions:

- Remove and replace cabinet-mounted piece parts, modules, assemblies or sub-assemblies.
- Repair modules, assemblies, or sub-assemblies designated as shipboard repairable.
- Turn in depot repairable items using prescribed supply procedures.

AN/SPS-40B/C/D RADAR WITH F.C. 1.3 THROUGH 10

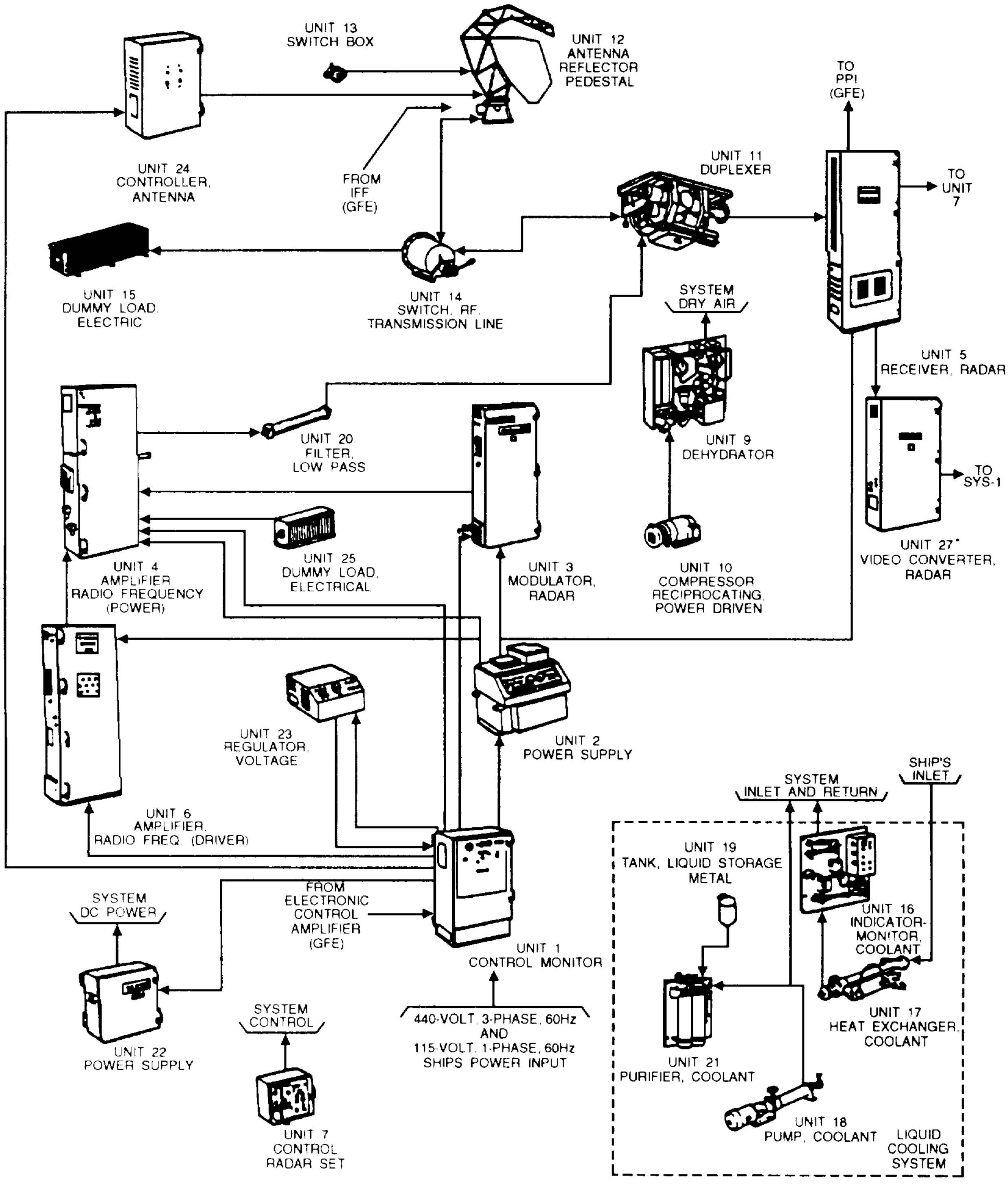


Figure 2-6.—AN/SPS-40B/C/D DMTI/RVC radar system.

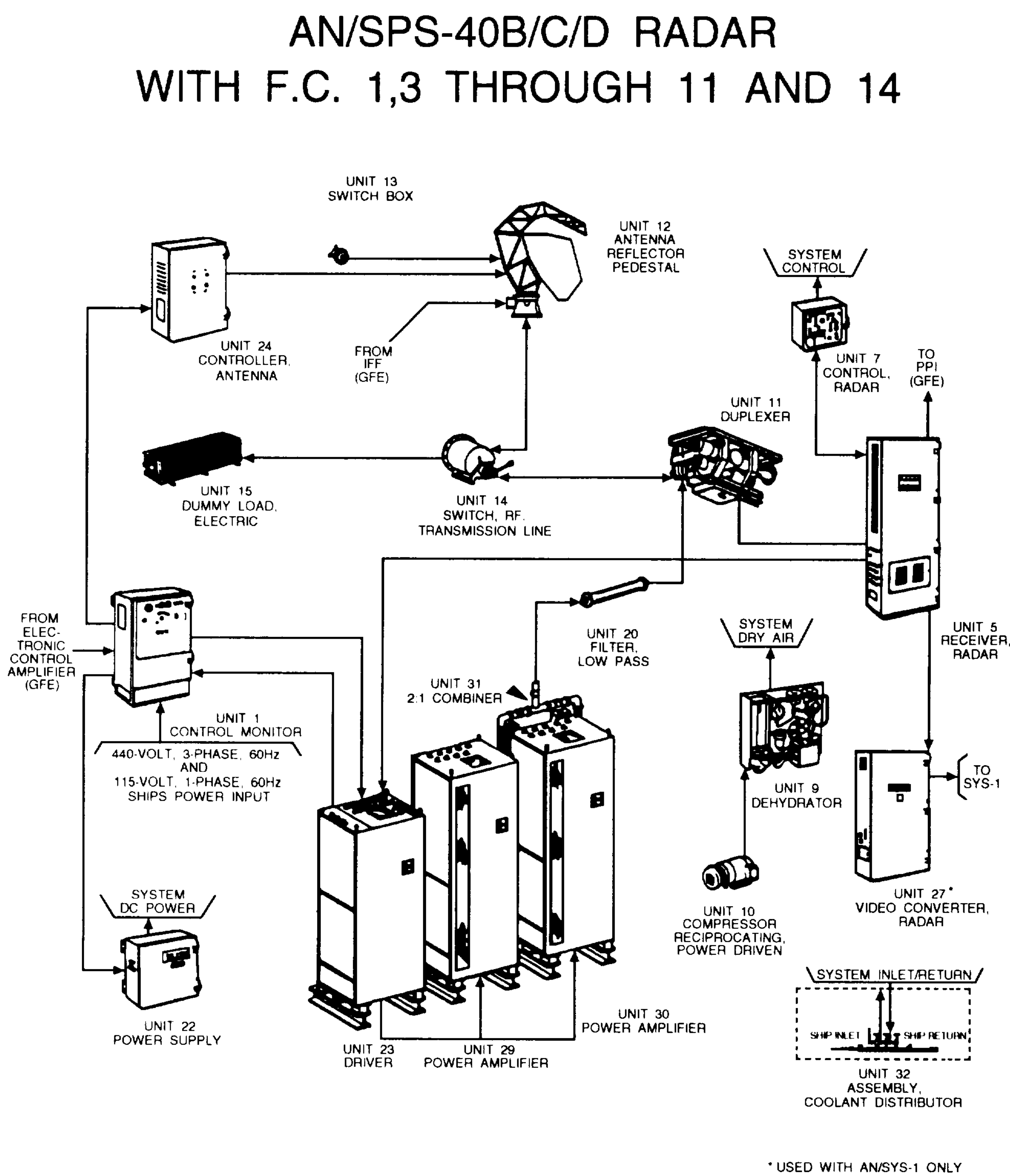


Figure 2-7.—AN/SPS-40E radar system.

System overhaul and restoration are performed on a turn-around basis every 10-15 years by naval shipyards or private contractors as directed by NAVSEA. Antenna and pedestal restoration is done on a turn-around basis, with the assembly aboard ship replaced about every 3 years.

AN/GPN-27 (ASR-8)

The Airport Surveillance Radar AN/GPN-27 is used at naval air stations (NAS) and Marine Corps air stations (MCAS) to detect aircraft within 60 nautical miles of the station and to generate plan position indicator (PPI) information for aircraft control.

General Theory of Operation

The AN/GPN-27 is a modular, solid-state, dual-channel, dual-beam/frequency diversity, S-band, surveillance radar used for safe, efficient movement of air traffic within the naval or Marine Corps Air Station National Airspace System area.

Some of the operating features include:

- Stable local oscillator (STALO)
- MTI with 10-bit design
- Clutter rejection
- Circular polarization
- Reduced side lobes
- Field-programmable range azimuth gate

Configuration

The AN/GPN-27 radar includes three major groups: an antenna group, a transmitter building group, and a display site group.

The *antenna group* consists of a reflector, dual-feed assembly, rotary joint, pedestal, and a dual-drive train assembly. It is a dual-beam design with normal and passive channels, including switchable linear and circular polarization. The cosecant-squared elevation pattern provides constant radiation altitude coverage up to 30 degrees above peak of beam. The passive, receiver-only feed horn is tilted upward from the normal beam to reduce interference from ground clutter at short ranges.

In the *transmitter building group,* the transmitter has an air-cooled klystron, a solid-state modularized modulator, and a solid-state, high-voltage power supply. The receiver provides normal video, log video, and moving target indicator (mti) video signals to the processor unit. The digital processor processes the receiver video for the radar tuning and control circuits, the range/azimuth gate generator, the azimuth pulse generator (APG), and the video cable-line drivers. The system control interface and distribution unit features a solid-state control system for radar command and status indications. A 16-inch maintenance plan position indicator (MPPI) aids in system alignment and maintenance. The transmitter building group also has two of the five stations (1 master and 1 slave) of the intercommunication system.

The *display site group* at the indicator site or air traffic control (ATC) room consists of a display site remote unit, two system control panels, a display site cable junction box, and an intercommunications system with three stations (2 master and 1 slave).

SIGNIFICANT INTERFACES.— The only interfacing is within the system itself. The control system contains control boxes that have release and take-control circuitry to ensure that radar command is available only at the selected control box. Operators scan the radar screen for incoming and outgoing aircraft, vector aircraft to the airfield, and work with other controllers to coordinate precision approach radars (PAR) and land aircraft.

FOR THE MAINTAINER.— The AN/GPN-27 uses state-of-the-art design and technology. All radar command and status signals stay in power-protected solid-state memory, isolating the control system from short-term power outages. The MPPI at the transmitter building aids in system alignment and other maintenance.

Maintenance

Maintenance of the AN/GPN-27 is performed on demand or as scheduled and is done by Electronics Technicians (NEC ET-1580). Organizational level maintenance includes fault isolation, performance testing, and alignment. Corrective maintenance consists of the removal and replacement of sub-assemblies, modules, and printed circuit boards (PCBs). Those items not repairable at the organizational level are returned to the depot facility through normal Navy supply channels.

THREE COORDINATE (3D) AIR SEARCH RADARS

Fire Control Technicians (FCs) usually maintain the height-finding radars installed aboard Navy ships. So, rather than cover specific equipment, we will cover general information to help you understand the overall radar capabilities of your ship.

The 3D radar functions much like the 2D system, but also provides elevation information. To do this, the height-finding radar uses a beam that is very narrow, both vertically and horizontally. Azimuth is provided as the antenna rotates continuously at speeds varying up to 15 rpm. Although the antenna usually operates in the automatic mode, the operator may control it manually for searching in a specific target sector.

As we mentioned in chapter 1, the air search 3D radars determine altitude by scanning the vertical plane in discrete increments (steps). Although this may be done mechanically, most frequently, it is done electronically. Figure 2-8 shows the radar beam radiated at different elevation angles as electronic scanning changes the radiated frequency in discrete steps. Each elevation angle or step has its own particular scan frequency.

A computer electronically synchronizes each radiated frequency with its associated scan angle to produce the vertical height of a given target.

The 3D radars also use a range-height indicator (RHI) in addition to the PPI used with 2D radars. We will discuss both indicators in further detail in the section on radar indicators.

CARRIER-CONTROLLED APPROACH (CCA) AND GROUND-CONTROLLED APPROACH (GCA) RADARS

Carrier-controlled approach (CCA) and ground-controlled approach (GCA) systems guide aircraft to safe landings, even under conditions approaching zero visibility. Radar is used to detect aircraft and to observe them during their final approach and landing. Guidance information is supplied to the pilot in the form of verbal radio instructions, or to the automatic pilot (autopilot) in the form of pulsed control signals.

The primary approach systems in the Navy are the AN/SPS-46(V) Precision Approach Landing System (PALS) for CCA and the AN/FPN-63 Precision Approach Radar (PAR) for CGA.

AN/SPN-46(V) PALS

The AN/SPN-46(V)1 system provides safe and reliable final approach and landing for PALS-equipped carrier-based aircraft, during daylight or darkness. It is rarely affected by severe weather and sea state conditions, and is not affected by low ceiling and visibility problems.

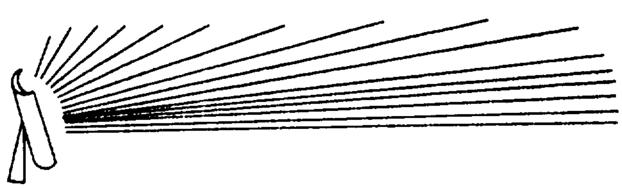


Figure 2-8.—Electronic elevation scan.

The AN/SPN-46(V)2 system is installed at selected naval air stations (NAS). It is used for the PALS training of flight crews, operator and maintenance personnel, and the PALS certification of aircraft.

The AN/SPN-46(V)1 system replaces the AN/SPN-42A Automatic Carrier Landing System (ACLS) on CV/CVN class ships. The AN/SPN-46(V)2 system replaces the AN/SPN-42T1/3/4 at various naval air stations.

General Theory of Operation

The AN/SPN-46(V) PALS allows simultaneous and automatic control of two aircraft during the final approach and landing phase of carrier recovery operations. Designed primarily as an “automatic” landing system, it also has manual control capabilities. The AN/SPN-46(V) has three modes of operation that are identified, based on the type of control (automatic or manual) and the source of information (display or voice).

Mode I (automatic control).—The Central Computer Subsystem (CCS) processes flight information from the radar/ship motion sensor (SMS), wind speed and direction equipment, and other ancillary equipment. It then transmits command and error signals to each aircraft via the Link 4A. The aircraft receives these command and error signals and translates them into control actions that maintain the aircraft within a narrowly prescribed flight envelope.

Mode II (manual control with display).—The aircraft cockpit display receives command and error signals that direct the pilot to take proper actions.

Mode III (manual control with voice).—The air traffic controller, using the processed flight data transmitted to the operator control console (OCC), provides the pilot with voice communications for a manual approach.

Configuration

The AN/SPN-46(V)1 system consists of 26 units categorized into four major subsystems: display (units 1 and 2), ancillary equipment (units 3-11), central computer (units 12- 16), and radar/SMS (units 17-26). A pictorial flow diagram of the system is shown in figure 2-9. The AN/SPN-46(V)2 functions the same as the AN/SPS-46(V)1, except that it does NOT use the MK 16 Mod 12 stable elements (units 17 and 18). Also, the (V)2 uses a 7-foot diameter antenna instead of the 4-foot antenna used for the (V)1.

The *display* subsystem consists of two identical operator control consoles (OCC) (units 1 and 2), one for each channel of the system. The OCCs allow the final controllers to control and monitor the AN/SPN-46(V) system. The OCC includes a radar display, a data generator, and an embedded computer. The OJ-314 system installed in the OCC provides operator communications.

The *ancillary equipment* subsystem includes aircraft control indicators (units 4, 6, and 7) for the Carrier Air Traffic Control Center (CATCC) and Primary Flight (PRI-FLI) areas. The PRI-FLI indicators (units 6 and 7) display the flight information and system status required for each OCC. The recorder-converter (unit 8) records selected system data. The landing signal officer (LSO) waveoff light (unit 10) provides the LSO with a visual indication of the system waveoff on the nearest aircraft under control.

The *central computer* subsystem (CCS), consisting of two identical AN/AYK- 14(V) computer sets, receives data from the radar/SMS and OCCs. It computes aircraft command and error signals and transmits them to controlled aircraft via Link 4A.

The *radar/ships motion sensor (SMS)* subsystem consists of two radar channels, each with an X-band receiver, a K_a-band transmitter, and an antenna. It consists of several units, including the receiver and antenna (units 24 and 25), Mk 16 stabilization elements (units 17 and 18), and embedded computer processors (unit 19). Aircraft tracking information (from the radar) combines with ship's stabilization data (from the Mk 16 gyros) and goes to the CCS for processing.

SIGNIFICANT INTERFACES.— The digital data switchboard (unit 14) provides an automatic switching interface between the master-slave computers in the central computer group (unit 12) and all external system peripherals required for PALS operation. The AN/TPX-42A(V)8 CATCC DAIR, AN/SSW-1C/D, and OA-7984(U)/UYK Input/Output (I/O) Control Console (unit 16) can all operate as the master computer of the CCS. Electrically operated switches automatically switch these equipment into a master or slave configuration in the central computer group. The AN/SPN-46(V) also interfaces with the AN/TPX-42(V)8 system through the power distribution panel (unit 3).

Other radars, such as the AN/SPN-35, the AN/SPN-43, and the AN/SPN-44, are also used in conjunction with the precession carrier controlled approach (CCA) system for landing operations.

AN/SPN-35.— The AN/SPN-35 radar set provides both azimuth and elevation data for precision approaches to aircraft carriers during adverse weather conditions. Using the radar display, the operator directs pilots along a predetermined glide path and azimuth courseline to a point one mile from the ship.

AN/SPN-43.— The AN/SPN-43 is a surveillance and air traffic control radar used on carriers and amphibious-type ships. It operates in a 2-4 GHZ frequency band (S-Band) and provides air navigational data for control and identification of aircraft in the area of the ship. With a range of 50 nautical miles, it tracks low-flying aircraft to a minimum of 250 yards and covers 360° at altitudes from radar horizon to 30,000 feet. The radar displays azimuth and range which the operator uses to direct control of the aircraft to the CCA transfer point. An IFF system, synchronized with the radar, provides positive identification of the aircraft.

AN/SPN-44.— The AN/SPN-44 is a range-rate radar set that computes, indicates, and records the speed of aircraft making a landing approach to the carrier. Both true and relative air speed are indicated. Supplied with this accurate information on the speed of the approaching aircraft, the LSO can wave off those attempting to land at an unsafe speed.

FOR THE MAINTAINER.— The AN/SPN-46(V) is a modernized PALS system that provides improved reliability, maintainability, and performance. It uses standard electronic modules (SEMs), an AN/USH-26 Magnetic Tape Unit (MTU) and standard computers (AN/AYK-14) to provide reliability and improved supply support.

The AN/SPN-46(V) has a self-monitor capability to prevent the transmission of erroneous control and error signals in Mode I and Mode II operation. It also displays the deck status.

The power distribution panel (unit 3) provides circuit breaker protection and acts as a junction box for all stabilization source inputs and outputs, and anemometer inputs. The PRI-FLI indicator control (unit 5) contains circuit breaker protection for PRI-FLI indicators (units 6 and 7) and a maintenance intercom for troubleshooting purposes. The recorder-converter

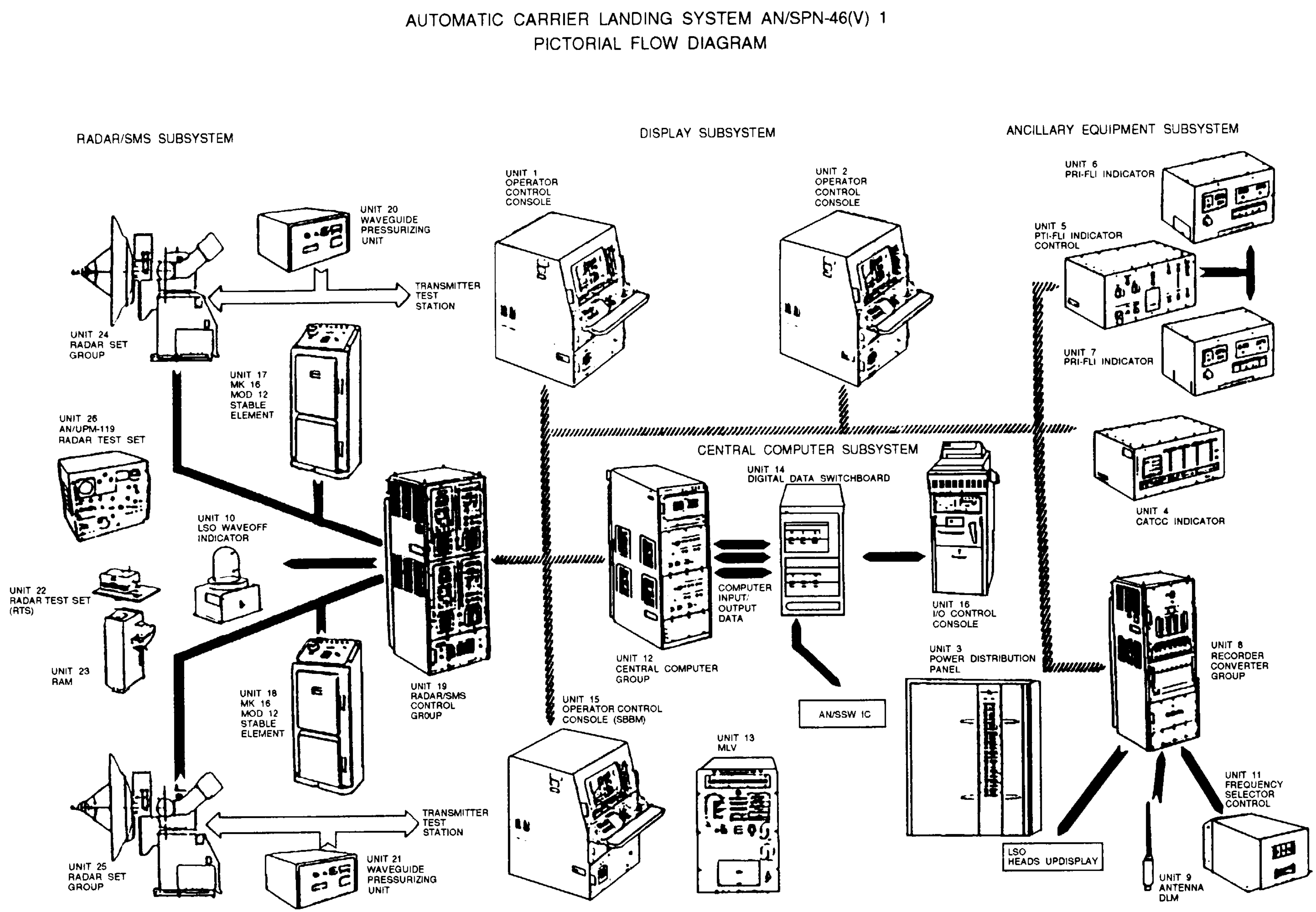


Figure 2-9.—AN/SPN-46(V)1 pictorial flow diagram.

group (unit 8) has a synchro test point panel to monitor input synchro voltages.

The OCC installed in the equipment room (unit 15) is a system/bootstrap bus monitor (SBBM) that performs on-line system testing and troubleshooting, and computer bootstrap program loading. The memory loader/verifier (MLV) (unit 13), stored in the equipment room, is used for the following purposes:

- Load and verify operational programs from cassettes
- Initiate AN/AYK-14 self-test and display results
- Load diagnostics and provide maintenance interface and control
- Write cassette memory with received data
- Display and change register and memory locations

The SPN radar test set (RTS) (unit 22) is used to align, calibrate, and maintain the radar/SMS subsystem. The retractable alignment mast (unit 23) elevates the SPN RTS and a collocated corner reflector to a minimum of 19 feet above the carrier flight deck for system calibration. The UPM radar test set (unit 26) is also used to test and calibrate the radar/SMS subsystem. This test set combines the functions of a spectrum analyzer and synchroscope to provide pulse or CW test signals and visual spectrum indication. It also has a direct reading cavity frequency meter, and a power level meter.

Maintenance

Organizational maintenance is performed by ET personnel (NEC ET-1524). It consists of removal and replacement of plug-in assemblies and chassis-mounted parts. You can isolate faults using the built-in-test (BIT), built-in-test equipment (BITE), general-purpose electronics test equipment (GPETE), special-purpose test equipment (SPETE), and maintenance assist modules (MAM).

Depot level maintenance includes repair of failed printed circuit boards (PCBs) or modules and major repairs, such as overhaul, refurbishment, and calibration.

AN/FPN-63 PAR

The AN/FPN-63(V) Precision Approach Radar (PAR) is used at naval air stations (NAS) and Marine Corps air stations (MCAS) for air traffic control operations. It replaces the PAR portion of the AN/CPN-4 family of equipment. The AN/MPN-23 is a version of the same equipment mounted on a trailer.

General Theory of Operation

Although the AN/FPN-63(V) is functionally and operationally similar to the PAR portion of the AN/CPN-4, it uses a modified version of the AN/CPN-4A PAR antenna system. The antenna modifications reduce signal side lobes and minimize ground and precipitation clutter. The AN/FPN-63(V) is based on solid-state circuitry and includes a digital moving target indicator (mti). The modification also includes a remote control subsystem that provides complete operational use of the PAR up to 10,000 feet from the radar van.

The solid-state AZ-EL range indicator generates its own internal map, sweeps, range marks, and cursors. A single curser adjustment allows alignment of each curser with the runway centerline.

Independent transmitters and receivers provide one operational channel and one “hot standby” channel. This allows the operator to use one set of equipment, while a technician performs maintenance on the other set. Thus, service is never interrupted.

Configuration

A remote control turntable unit and the associated remote control panels allow positioning of the radar for multiple runway operation. Stations not requiring multiple runway operation use a fixed-mounted AN/FPN-63.

All radar components are in racks and enclosures of the radar sets, with empty spaces covered by blank front panels. The number of indicators varies by site.

Maintenance

Organizational maintenance is performed by ET personnel (NEC ET-1579) and includes performance verification, testing, alignment, and fault isolation. Repair of equipment consists of the replacement of discrete chassis components and piece parts.

The prime contractor performs all depot-level maintenance. If you have any modules or PCBs that your organization cannot repair, return them to the depot facility.

RADAR INDICATORS (REPEATERS)

The purpose of a radar indicator (repeater) is to analyze radar system echo return video and to display that information at various remote locations. For the repeater to present correct target position data, it must have three specific inputs from the radar selected: video input, trigger (timing) pulses, and antenna information.

A *video input* from the radar via a video amplifier for each returning echo enables the repeater to display detected **targets.**

Trigger (timing) pulses from the radar ensure that the sweep on the repeater starts from its point of origin each time the radar transmits. This allows repeaters to display the target at actual **range** from the radar based on the time lapse between the instant of transmission and the instant of target echo receipt.

Antenna information from the radar allows the angular sweep position of the repeater to be synchronized with the angular position of the radar antenna. This will produce and display the target at its actual **bearing** (azimuth) from the radar.

The three most common types of displays are the A scope (range-only indicator), the PPI scope (range-azimuth indicator), and the RHI scope (range-height indicator). The A scope, limited by its range-only capability, is normally considered an auxiliary display rather than a radar repeater. The PPI scope is by far the most used radar repeater.

PLANNED POSITION INDICATOR (PPI)

The PPI is a polar-coordinate display of the surrounding area with the origin of the sweep (normally located at the center of the screen) representing your radar. The PPI uses a radial sweep pivoting about the center of the presentation, resulting in a maplike picture of the area covered by the radar beam. A relatively long-persistence screen is used so targets will remain visible until the sweep passes again.

Bearing is indicated by the target's angular position in relation to an imaginary line extending vertically from the sweep origin to the top of the scope. The top of the scope represents either true north (when the radar is operating in true bearing), or ship's head (when the radar is operating in relative bearing).

To allow a single operator to monitor several tactical data inputs from one location, many radar repeaters are being replaced with multipurpose consoles on Naval Tactical Data Systems (NTDS) equipped ships. However, radar repeaters still serve as a back-up to the consoles used on NTDS ships and are irreplaceable on non-NTDS ships.

The most common radar indicator group used in the Navy is the AN/SPA-25G. This Radar Display and Distribution System usually includes the AN/SPA-25G Indicator, the CV-3989/SP Signal Data Converter, and the SB-4229/SP Switchboard.

AN/SPA-25G Indicator Group

The AN/SPA-25G Indicator Group is found on 90 percent of all Navy ships. It meets the diverse mission requirements of antiair warfare, antisurface warfare, antisubmarine warfare, electronic warfare, strike and amphibious warfare, as well as navigation and bridge requirements such as piloting and station keeping. The AN/SPA-25G will replace the AN/SPA-4, SPA-8, SPA-25, SPA-33, SPA-34, SPA-40, SPA-41, and SPA-66. The AN/SPA-50 and SPA-74 radar display system/indicator groups are also potential candidates for replacement by the AN/SPA-25G.

The AN/SPA-25G is an advanced, solid-state (except the CRT display) radar indicator for both Combat Information Center (CIC) and bridge environments. It can receive multiple data inputs, including three radar video signals from the same radar, radar triggers, antenna synchro data, external course and speed, off-centering inputs, and dead reckoning analyzer (DRA) inputs.

The various radar inputs, except video that is in analog form, are in the Radar Display and Distribution Systems (RADDS) serial 64-bit data stream format. The data is continually processed through five megabits of digital memory. By correlating the radar data with internally generated graphic symbols, the operator can fully interact with the displayed information on the CRT. Figure 2-10, the AN/SPA-25G top panel layout, shows all of the operational controls and indicators.

Some of the significant design features of the AN/SPA-25G include:

- High Definition Raster Scan Display-enables the AN/SPA-25G to perform at maximum capacity, without a hood, in either the subdued lighting of CIC or the bright daylight on the ship's bridge.

- Flicker Reduction—provides an effective display refresh rate that suppresses flicker in any lighting environment.

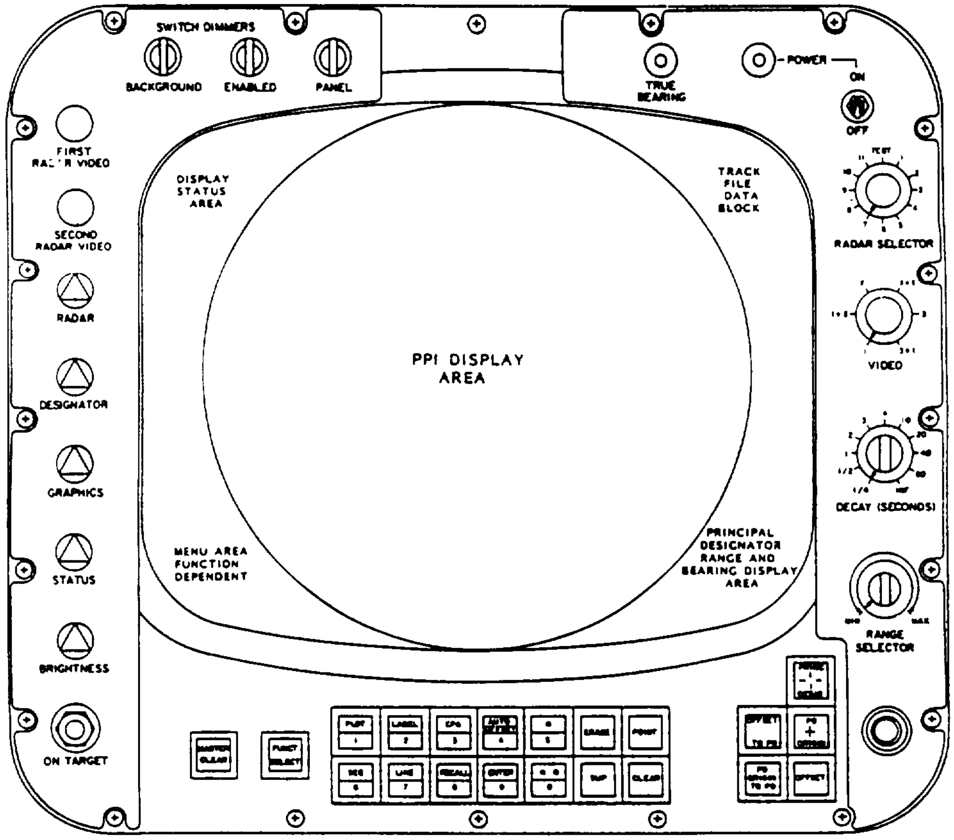


Figure 2-10.—AN/SPA-25G radar indicator, top panel controls and indicators.

- Azimuth Fill process—prevents voids, gaps, and holes in the radar video that occur when translating from rhotheta to X-Y format.

- Electronic Bearing Circle—around the perimeter of the radar video display, has bearing markers displayed every 5°, and is numerically labeled every 10°.

- Electronic Plotting Aid—provides a continuous display of ship's speed and course, offset settings, principal designator range and bearing, and BIT message.

Figure 2-11 shows the physical configuration of the AN/SPA-25G. It has the same form and fit as previous indicator group models in the AN/SPA-25 series. It will pass through a 25-inch diameter hatch without disassembly. If a tilted panel or sit-down console is required, a 60° insert section and an attachable front shelf are available (fig. 2-12).

The AN/SPA-25G has unlimited operational capabilities, since it will interface with any Navy conventional search radar system. The CV-3989/SP

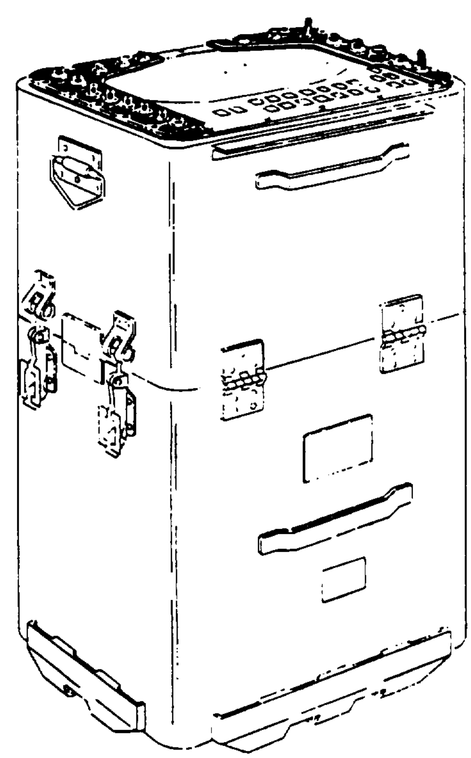


Figure 2-11.—AN/SPA-25G stand-up configuration.

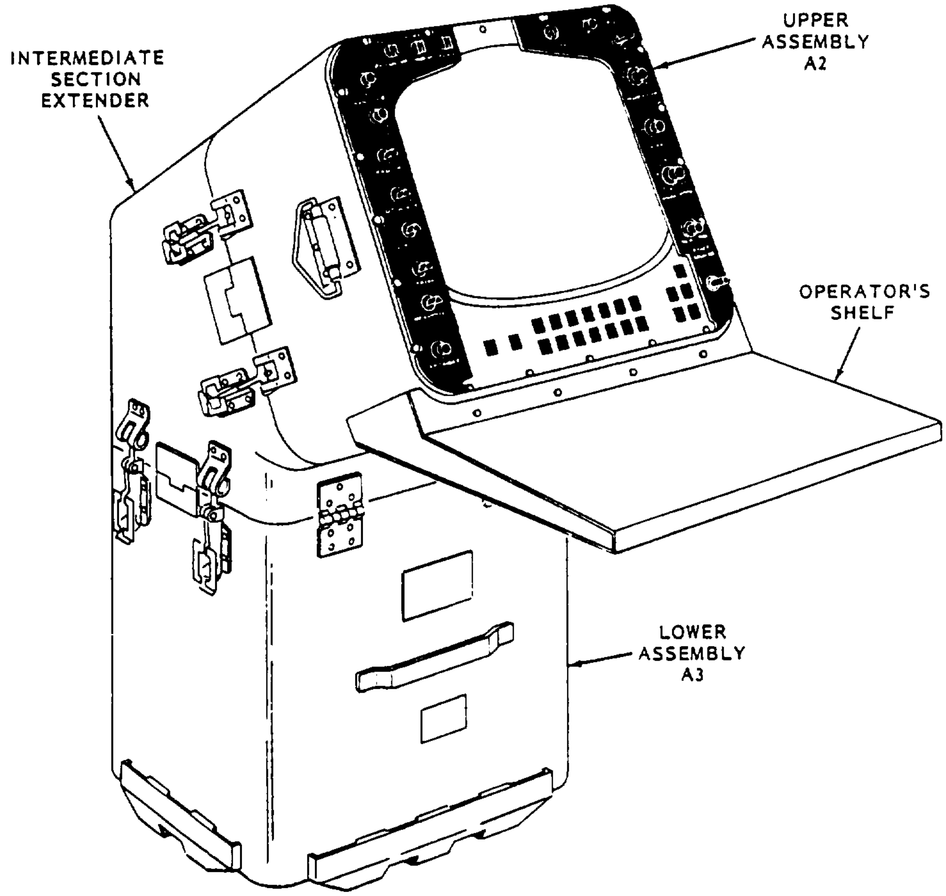


Figure 2-12.—AN/SPA-25G with insert section.

Signal Data Converter provides the primary interface between conventional equipment by multiplexing analog information into a single digital data stream for use by the AN/SPA-25G.

The AN/SPA-25G allows the maintainer to localize faults quickly by using built-in-test (BIT) and test messages for circuit and module checkout.

CV-3989/SP Signal Data Converter

The Signal Data Converter CV-3989/SP (SDC), shown in figure 2-13, is designed for installation inside the shipboard radar room. It is mated to the radar (triggers), antenna azimuth, ship's gyro-heading, and ship's speed or distance (ship's pit log).

The SDC conditions and multiplexes the various data inputs into a single digital data (RADDS) stream. This permits a single cable to distribute RADDS stream data throughout the ship. Previous distribution of radar and navigation data required multiple cables. The SDC accepts radar and navigation inputs and converts them into five independent serial digital data (RADDS stream) outputs. Over a single coaxial cable, the following data is provided by the SDC RADDS data stream:

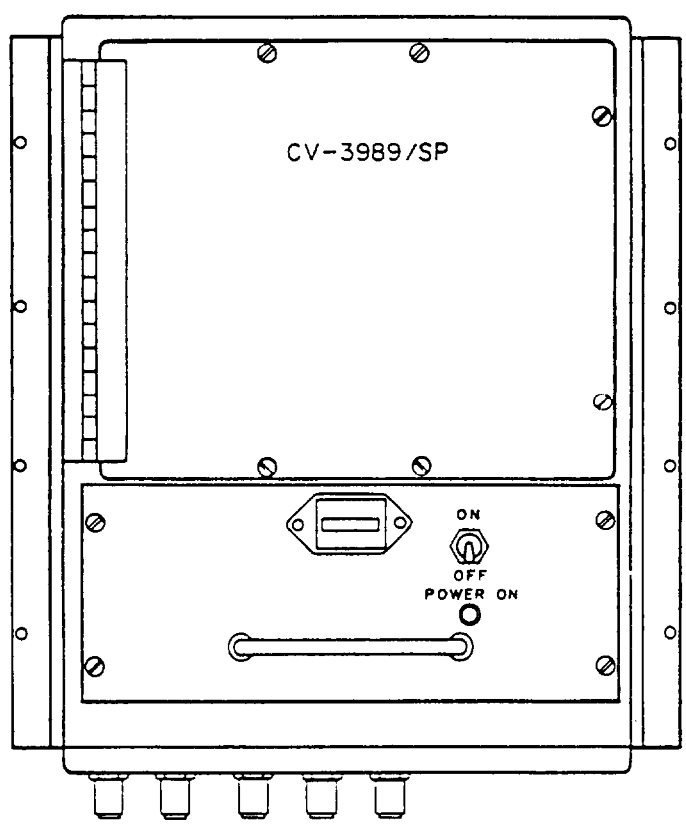


Figure 2-13.—Signal Data Converter, CV-3989/SP.

- Radar trigger(s)
- Radar antenna azimuth (stabilized and unstabilized)
- Dead reckoning information
- Ship's heading
- Radar set sensor ID

The SDC also contains the necessary circuitry for future growth and expanded use in data distribution. A compatible switchboard is required to interface the data from various radar sets with other systems.

SB-4229/SP Switchboard

The SB-4229/SP switchboard, shown in figure 2-14, replaces all SB-440, SB-1109, and SB-1505 switchboards. It provides selectable distribution of data from any Navy conventional search radar set. The CPU-controlled switchboard can accept signals from 16 radar sets and five IFF interrogator sets, then distribute them to nine individual radar indicators and nine IFF decoders. It can also accept mode control from any IFF decoder associated with any of the radar indicators and switch the mode control of the IFF interrogator associated with the radar set being viewed on that indicator. This process is explained in more detail in chapter 3.

The SB-4229/SP switchboard allows radar and IFF signals from ship's radar and RADDS data stream inputs to be selected from up to 16 signal data converters. It provides up to nine selectable outputs to the AN/SPA series radar indicators. So, up to nine different operators can select one of 16 input sensors to display at their indicator. Each of the 16 input sensors can consist of three radar videos, RADDS data stream, and IFF control with its associated videos. The more significant design features include:

- Local or remote selection of input sensors
- Conversion of RADDS data stream back to analog (for older indicators)
- Distribution of any of the 16 input sensors to any of up to nine separate radar indicators
- Detection of improper operation by self-test (BIT)

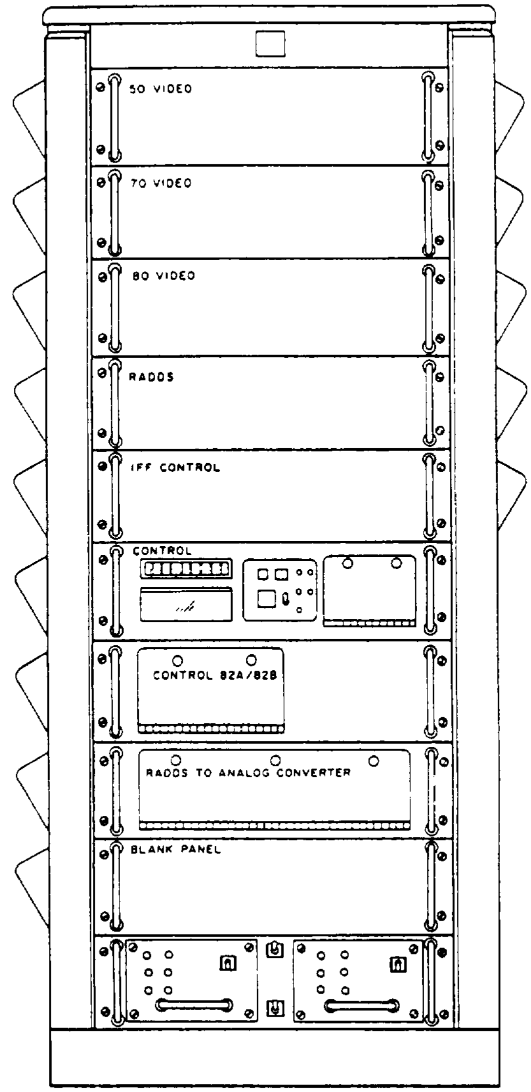


Figure 2-14.—Radar Distribution switchboard, SB4229/SP.

Maintenance

The maintenance of the AN/SPA-25G, CV-3989/SP, and the SB-4229/SP is performed by the Electronics Technician (ET) assigned maintenance responsibilities for the surface search radar or conventional radar display and distribution systems.

Organizational maintenance consists of corrective and preventive maintenance actions. Preventive maintenance is performed according to the maintenance requirement cards (MRCs).

Shipboard personnel perform corrective maintenance according to the corrective maintenance sections of the applicable technical manuals and as reflected by the maintenance code assigned in the equipment APL. CM may require (1) removal or replacement of cabinet mounted piece parts, (2) replacement of components, assemblies, or sub-assemblies, or (3) repair of certain units, assemblies or sub-assemblies designated as “shipboard repairable.” It may then require “turn in” of depot repairable assemblies or sub-assemblies through prescribed supply procedures.

All replaceable modules, assemblies or printed circuit boards with a replacement value of $500 or more (except the CRT and high-voltage power supplies) are designed and constructed to be repairable by component replacement at the depot maintenance level.

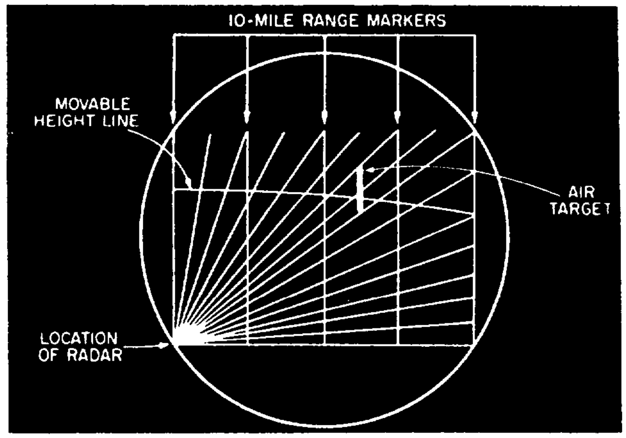


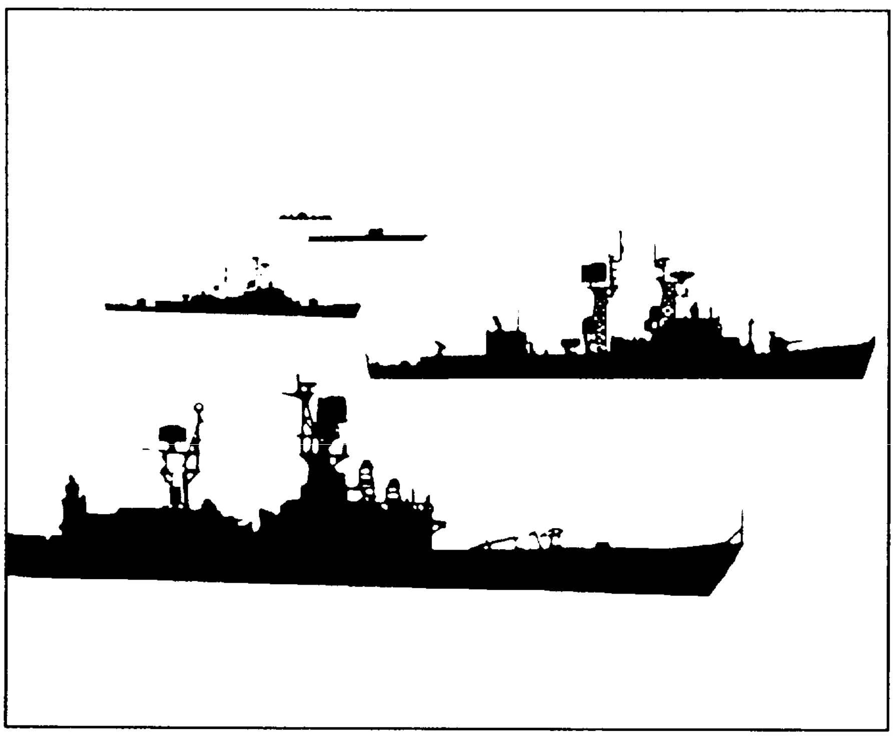
Figure 2-15.—RHI presentation.

RANGE-HEIGHT INDICATOR (RHI)

The range-height indicator (RHI) scopes used with height-finding radars obtain and display altitude information. The RHI is a two-dimensional presentation showing target range and altitude. An example of a RHI presentation is shown in figure 2-15.

The sweep of a RHI starts in the lower left side of the scope and moves across the scope to the right at an angle that is the same as the angle of transmission of the height-finding radar. The line of sight to the horizon is indicated by the bottom horizontal line. The point directly overhead in the sky (the zenith) is straight up the left side of the scope. Targets are displayed as vertical blips. Vertical range markers are provided to estimate target range.

The operator determines altitude by adjusting the moveable height line to the point where it bisects the center of the target blip. Target height is then read directly from altitude dials (counters).



SUMMARY

In chapter 1, you reviewed the basics of the theory of radar operation. In this chapter, you learned some basics about specific equipment used in the fleet.

You now know which missions, on what types of ships, are supported by surface search and navigation radars, such as the AN/SPS-67(V), the AN/SPS-64(V)9, and the AN/SPS-55. You are aware of some of the special operating, maintenance, and safety features of these radars. You can identify, during troubleshooting, which systems they interface with.

You learned the same types of things about the 2D air search radars used by the Navy, such as the AN/SPS-49(V), the AN/SPS-40B/C/D/E, and the AN/SPS-65(V) aboard ships and the AN/GPN-27 (ASR) at shore installations. These are air search radars that you will maintain.

Although the FCs will usually maintain the 3D radars aboard your ship, you must understand how they operate in the scheme of the overall radar mission.

Knowledge of carrier controlled approach and ground controlled approach radar systems such as the AN/SPN-46(V) and the AN/FPN-63 is essential in the high-tech warfare we use today. Successful air strikes and air cover are the key to any military victory.

Multipurpose consoles are replacing many of the radar repeaters on Naval Tactical Data Systems (NTDS) equipped ships. But, radar repeaters still serve as a back-up to the consoles used on NTDS ships and are irreplaceable on non-NTDS ships. So, it is still necessary that you know radar information is provided by displays such as radar indicators. The A scope (range-only indicator) is used primarily by the maintenance personnel to evaluate the operation of the radar. The PPI scope (range-azimuth indicator) is the most commom usually consisting of a Radar Display and Distribution System, including the AN/SPA-25G Indicator, the CV-3989/SP Signal Data Converter, and the SB-4229/SP switchboard. The RHI scope (range-height indicator) is used with height-finding radars to obtain and display altitude information.

The *Handbook for Shipboard Surveillance Radars,* NAVSEA SE 200-AA-HBK-010, provides information on radar fundamentals and “rules of thumb” to the level that will allow you to interpret technical specifications and performance statements with respect to radar performance requirements. This is a good publication to review if you want to make a suggestion for improvement or modification to a radar system. This handbook provides technical support and back-up data for shipboard radar systems engineers. However, it also provides fundamental and descriptive information for Navy radar users, including radar principles and shipboard surveillance radar characteristics.

In chapter 3, we will discuss some of the systems that use radar information. We'll discuss the equipment involved with IFF and DAIR, and also look at some of the unique maintenance concepts of the Navy Tactical Data System (NTDS).